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Abstract

According to the 2006 Census, almost 20% of the Canadian population were foreign-born, a percentage that is projected to reach at least 25% by 2031. Studies based on age-standardized mortality rates (ASMR) have found a healthy immigrant effect, with lower overall rates among immigrants. A duration effect has also been observed—immigrants' mortality advantage lessened as their time in Canada increased. ASMRs based on the 1991 to 2001 census mortality follow-up study indicate a healthy immigrant effect and a duration effect at the national level for all-cause mortality for both sexes. However, at the national level, the mortality rate among women from the United States and from Sub-Saharan Africa was similar to that of Canadian-born women. For the three largest Census Metropolitan Areas (Toronto, Montreal and Vancouver), a healthy immigrant effect was not observed among women or among most men from the United States or Sub-Saharan Africa.

Keywords

Age-standardized mortality rate, death rate, longitudinal, record linkage

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In 2006, immigrants made up one-fifth (19.8%) of Canada's population, a percentage that is expected to reach at least 25% by 2031.[1] The health and the health services needs of this large and growing share of the population are not necessarily the same as those of people born in Canada.[2,3] Research has repeatedly found a "healthy immigrant effect"—immigrants' health is generally better than that of the Canadian-born, although it tends to decline as their years in Canada increase.[4-14] However, the relationship between immigration and health is complex, especially because the origins of immigrants to Canada are increasingly diverse. Since the 1960s, the major source countries have shifted from European to non-European nations. Consequently, it is important to analyze the healthy immigrant effect by birthplace and period of immigration.

The present analysis used the 1991 to 2001 Canadian census mortality follow-up study to explore associations between mortality and birthplace and period of immigration (see *The data*). The objectives were to determine:

1. if immigrants have better health, as measured by age-standardized mortality rates (ASMRs) than does the Canadian-born population (overall healthy immigrant effect);
2. if immigrants' initial health advantage lessens over time (duration effect); and
3. if the results hold for immigrant subgroups, by birthplace and by selected country at the national level and for the three largest Census Metropolitan Areas (CMAs)—Toronto, Montreal and Vancouver (where possible).

The adult immigrant population

The total 1991 to 2001 Canadian census mortality follow-up cohort numbered 2.7 million individuals who were aged 25 or older in 1991; 552,300, or 20% of them, were immigrants. Close to 50% of these immigrants were born in Western Europe (comprising North, South and West Europe), followed by Eastern Europe (13%), the Caribbean/Central and South America (8%), and East Asia (8%). The majority (56%) were established immigrants who arrived in Canada before 1971; 23% arrived between 1971 and 1981; and 21% were more recent immigrants who arrived in the 1981-to-1991 period. Immigrants from Europe and the United States were more likely to be "established," while those from Asia and Africa were more likely to be "recent." For example, 80%

The data

The 1991 to 2001 Canadian census mortality follow-up study is a probabilistically linked cohort consisting of a 15% sample (n = 2,735,152) of the non-institutionalized population aged 25 or older, all of whom were enumerated via the 1991 census long-form questionnaire. This cohort was tracked for mortality from June 4, 1991 through December 31, 2001. Because names were not captured on the census database, but were needed to link to the mortality data, creation of the cohort required two probabilistic linkages. First, eligible census respondents were linked to a nominal list (name) file (abstracted from 1990 and 1991 tax-filer data and then encrypted) using common variables such as date of birth and postal code; 80% of eligible respondents were successfully matched. Then, the census plus encrypted names were matched to the Canadian Mortality Database. Based on 1991 deaths, which could be identified independently in the Canadian Mortality Database and/or the name file, ascertainment of deaths in the cohort followed for mortality was estimated to be 97% overall. Specifically, more than 260,000 deaths over the 10.6-year follow-up period were linked to the cohort.[15]

The 1991 Census defined immigrants as people who were, or who had been, landed immigrants in Canada. A landed immigrant is not a Canadian citizen by birth, but has been granted the right to live in Canada permanently. In this study, the Canadian-born population (non-immigrants) is the reference group. The analysis excluded refugee claimants and non-permanent residents (on employment or student authorizations).

To examine the duration aspect of the healthy immigrant effect, immigrants were classified by period of immigration and by place of birth. The period-of-immigration categories were: before 1970 (established), 1970 through 1980 (medium-term), and 1981 through June 1991 (recent). The world regions of birth were defined as: United States, Caribbean/Central and South America, Western Europe, Eastern Europe, Sub-Saharan Africa, North Africa/Middle East/West Asia, South Asia, South East Asia, East Asia, and Oceania. These are non-standard 1991 Census classifications of place of birth, established in order to achieve a balance between creating homogeneous categories for epidemiological research and having a manageable number of groups. For example, for conciseness, South, Central, West and East Africa were combined, whereas North Africa, the Middle East and West Asia were grouped because the people in these regions share cultural and epidemiological characteristics. South Asia, South East Asia and East Asia were categorized separately according to the 1991 Census definition, except that Singapore, which is part of South East Asia in the census definition, was included in East Asia. For Europe, the standard 1991 Census groupings of West, South and North Europe were combined with the Scandinavian countries as Western Europe, except that Albania and Yugoslavia, which are part of South Europe in the census definition, were included with Eastern Europe. South and Central America (including Mexico) and the Caribbean were combined. The United States of America was singled out as a place of birth instead of being part of North America. Greenland and St. Pierre and Miquelon, the other two components of North America, were included with Oceania. However, Oceania was dropped from the analyses by world region of birth because of the small sample size (n=4,600).

Immigrants from three countries—China (including Hong Kong), India and the United Kingdom—were selected for more in-depth analysis. Because the baseline data were obtained in 1991, before the influx of immigrants from the People's Republic of China, those in the sample who were born there most likely lived in Hong Kong before coming to Canada. For this analysis, the People's Republic of China and Hong Kong were grouped as China.

This study also examines mortality in three Census Metropolitan Areas (CMA): Toronto, Montreal and Vancouver.

Age- and sex-specific mortality rates by 5-year age group (at baseline) were used to derive age-standardized mortality rates (ASMRs), with the population structure of the census mortality follow-up cohort as the standard. ASMRs were calculated at the national level by sex for:

1) total population
2) Canadian-born population (reference)
3) total immigrant population and by period of immigration.
4) immigrant population by world region of birth and then by period of immigration.
5) immigrant population for China, India and the United Kingdom.

These calculations were repeated for the three CMAs, except for period of immigration, which was not possible because of small sample sizes. Rate ratios were calculated to determine if the ASMRs for various immigrant subgroups were significantly different from those for the Canadian-born population, and therefore, indicated a healthy immigrant effect. The duration effect was determined based on whether immigrants' health advantage lessened, as reflected in rising ASMRs with increased years in Canada as indicated by period of immigration.

The coefficient of variation was used to ensure that the ASMR estimates could be released; estimates with a coefficient of variation larger than 33.3% were suppressed.

This study has several limitations. First, even with such a large database, sample size becomes a problem with finer geographic breakdowns. A second possible limitation is differential attrition in the census mortality follow-up database. If immigrants are more likely than the Canadian-born to leave the country, a healthy immigrant effect might partly be explained by this differential loss to follow-up. However, while the possibility of immigrants moving out of the country exists, this is most common among younger people. Mortality rates at younger ages tend to be low, so such attrition should not have a noticeable impact on the results. Third, the analysis is limited by the lack of information about risk factors, such as physical activity, body mass index, smoking, nutrition and alcohol consumption.

Finally, immigration category (economic, family or refugee) may be an important determinant of post-immigration health outcomes; however, such data are not available in the 1991 to 2001 census mortality follow-up study.

of immigrants from Western Europe arrived before 1971, whereas the figure for immigrants from South Asia was 8%.

In this study, close to one in five immigrant adults (19%) was aged 65 or older, compared with 15% of Canadian-born adults. The higher percentage of seniors among immigrants reflected the higher percentage who had been born in Europe and the United States and is indicative of the diverse waves of immigration and settlement patterns that have occurred in Canada. For instance, 36% of immigrants in the study from Eastern Europe were seniors, compared with 5% of those from Sub-Saharan Africa and Western Asia.

More than half (54%) of immigrant adults lived in Toronto, Montreal or Vancouver. The percentage varied from 28% of those from the United States to 73% of those from the Caribbean/Central and South America. By comparison, 25% of Canadian-born adults lived in these three cities.

Healthy immigrant effect: Lower mortality rates

For Canada's adult population overall, the age-standardized mortality rates (ASMRs) per 100,000 person-years at risk were 1,230 for men and 703 for women. Immigrants had significantly lower ASMRs than did Canadian-born adults: 1,006 versus 1,305 for men, and 610 versus 731 for women (Table 1).

However, as immigrants' time in Canada lengthened, their ASMRs tended to rise. It is hypothesized that this upward trend in ASMRs reflects a loss of immigrants' health advantage over time. The AMSRs among men were 720, 913 and 1,054 for recent, medium-term and established immigrants, respectively. Among immigrant women, the corresponding rates were 491, 546 and 637. Nonetheless, these rates remained significantly lower than those of the Canadian-born population.

Birthplace matters

ASMRs varied widely depending on where immigrants had been born (Table 1). Among men, ASMRs ranged from 668 (South Asia) to 1,112 (United States); among women, the range was from 439 (Southeast Asia) to 699 (United States). Despite these wide variations, the ASMRs of immigrants were generally lower than those of Canadian-born adults. The only exceptions were women from the United States and from Sub-Saharan Africa whose ASMRs were similar to that of Canadian-born women.

Table 1
Age-standardized mortality rates,† by sex, birthplace and period of immigration, non-institutional cohort members aged 25 or older at baseline, Canada, 1991 to 2001

	Men	Women
Total	**1,230**	**703**
Canadian-born	**1,305**	**731**
Immigrants (total)	**1,006***	**610***
Before 1971	1,054*	637*
1971 to 1980	913*	546*
1981 to 1991	720*	491*
United States	**1,112***	**699**
Before 1971	1,104*	729
1971 to 1980	1,110*	636*
1981 to 1991	953*	739
Caribbean/Central and South America	**825‡***	**487‡***
Before 1971	893*	552*
1971 to 1980	817*	475*
1981 to 1991	750*	409*
Western Europe	**1,055‡***	**642‡***
Before 1971	1,070*	649*
1971 to 1980	1,056*	587*
1981 to 1991	898*	573*
Eastern Europe	**1,048‡***	**605‡***
Before 1971	1,062*	609*
1971 to 1980	954*	573*
1981 to 1991	862*	533*
Sub-Saharan Africa	**903***	**640**
Before 1971	825*	677
1971 to 1980	990*	636
1981 to 1991	992	600
North Africa/Middle East/ West Asia	**813‡***	**512***
Before 1971	937*	538*
1971 to 1980	825*	579*
1981 to 1991	556*	395*
South Asia	**668‡***	**550***
Before 1971	861*	579*
1971 to 1980	703*	603
1981 to 1991	509*	517*
South East Asia	**669***	**439‡***
Before 1971	606*	530*
1971 to 1980	792*	432*
1981 to 1991	627*	419*
East Asia	**794‡***	**470‡***
Before 1971	952*	501*
1971 to 1980	819*	486*
1981 to 1991	636*	402*

† per 100,000 person-years at risk
‡ support for duration effect
* significantly different from Canadian-born population
Note: Reference population (person-years at risk) for age standardization was taken from age distribution of entire cohort (5 -year age groups).
Source: 1991 to 2001 Canadian census mortality follow-up study

The study results indicate that ASMRs for immigrants from most regions of the world increased with time in Canada (duration effect):

- among both sexes – from the Caribbean/Central and South America; Western Europe; Eastern Europe; East Asia.
- among men only – North Africa/ Middle East/West Asia; South Asia.
- among women only – South East Asia.

However, the rise in ASMRs with duration of residence in Canada did not occur in all cases. For example, men who came to Canada from Sub-Saharan Africa before 1971 had a lower ASMR (825) than did those who arrived in the 1981-to-1991 period (992).

Toronto, Montreal and Vancouver

ASMRs in Toronto, Montreal and Vancouver also support the healthy immigrant effect For instance, the ASMR for immigrant men in Toronto was 974, significantly below the 1,280 for Canadian-born men in that CMA; the corresponding figures for women were 589 and 775 (Table 2).

ASMRs at the CMA level are heavily influenced by immigrants' birthplace and period of immigration. At least 40% of the immigrants in each of Toronto, Montreal and Vancouver came from Western Europe and had been in Canada for more than ten years. As a result, while ASMRs were lower compared with the Candian-born, overall ASMRs were closer to the levels for Western European immigrants who made up a larger percentage of the population in the study, compared with immigrants from

Table 2
Age-standardized mortality rates,† by sex and birthplace, non-institutional cohort members aged 25 or older at baseline, Toronto, Montreal, Vancouver, 1991 to 2001

	Men	Women
Canadian-born		
Toronto	1,280	775
Montreal	1,393	680
Vancouver	1,233	731
Immigrants (total)		
Toronto	974*	589*
Montreal	929*	463*
Vancouver	982*	613*
United States		
Toronto	1,129	671
Montreal	1,262	617
Vancouver	1,109	719
Caribbean/Central and South America		
Toronto	869*	546*
Montreal	842*	386*
Vancouver	611*	396*
Western Europe		
Toronto	1,062*	633*
Montreal	958*	476*
Vancouver	1,080*	676*
Eastern Europe		
Toronto	1,014*	587*
Montreal	934*	458*
Vancouver	1,016*	629*
Sub-Saharan Africa		
Toronto	881*	674
Montreal	F	F
Vancouver	1,135	810
North Africa/Middle East/ West Asia		
Toronto	698*	586*
Montreal	872*	447*
Vancouver	364*	F
South Asia		
Toronto	784*	626
Montreal	422*	455
Vancouver	752*	523*
South East Asia		
Toronto	593*	432*
Montreal	765*	475*
Vancouver	701*	470*
East Asia		
Toronto	775*	459*
Montreal	756*	363*
Vancouver	829*	499*

† per 100,000 person-years at risk
* significantly different from Canadian-born population
F too unreliable to be published
Note: Reference population (person-years at risk) for age standardization was taken from age distribution of entire cohort (5 -year age groups).
Source: 1991 to 2001 Canadian census mortality follow-up study.

Table 3
Age-standardized mortality rates,† for immigrants from China, India or United Kingdom, by sex, non-institutional cohort members aged 25 or older at baseline, Toronto, Montreal, Vancouver, 1991 to 2001

	Men	Women
Canadian-born		
Toronto	1,280	775
Montreal	1,393	680
Vancouver	1,233	731
Immigrants (total)		
Toronto	974*	589*
Montreal	929*	463*
Vancouver	982*	613*
China		
Toronto	790*	460*
Montreal	765*	373*
Vancouver	854*	502*
India		
Toronto	796*	634
Montreal	437*	503
Vancouver	779*	515*
United Kingdom		
Toronto	1,146*	700*
Montreal	1,019*	580*
Vancouver	1,083*	700

† per 100,000 person-years at risk
* significantly different from Canadian-born population
Note: Reference population (person-years at risk) for age standardization was taken from age distribution of entire cohort (5 -year age groups).
Source: 1991 to 2001 Canadian census mortality follow-up study.

Asia, whose ASMRs tended to be lower, but who made up a smaller percentage of the overall CMA immigrant population at that time.

For women in the three CMAs who had been born in the United States or in Sub-Saharan African countries, ASMRs were closer to those of Canadian-born women living in these locations. As well, the healthy immigrant effect was less evident among men from the United States living in these three CMAs—their ASMRs more closely resembled those of the Canadian-born than those of other immigrant groups. By contrast, for the Sub-Saharan African group, in Toronto, where close to half of them lived, ASMRs of male immigrants compared favourably with those of other immigrant groups.

China, India and the United Kingdom

In the 1991-to-2001 census mortality follow-up study, China (including Hong Kong) and India were leading source countries of recent immigrants to Canada, whereas the United Kingdom had been a major source in the past.

Overall, a healthy immigrant effect was apparent among immigrants from each of these countries. The ASMRs among men were 690 for those from India, 810 for those from China, and 1,105 for those from the United Kingdom; this compared with 1,305 for Canadian-born men (data not shown). Among women, the ASMRs were 537 (India), 471 (China), 695 (United Kingdom) and 731 (Canadian-born).

At the CMA level, ASMRs for immigrants from these three countries were generally lower than those for the Canadian-born population (Table 3). The exceptions were women from India living in Toronto (634) and in Montreal (503) and women from the United Kingdom residing in Vancouver (700), whose ASMRs did not differ significantly from those of Canadian-born women in these CMAs.

When cause of death is examined, the elevated ASMR among women from India at the CMA level reflects higher circulatory disease ASMRs (data not shown).[16] Similarly, in Vancouver, the higher ASMR among women from the United Kingdom was partially due to circulatory disease and cancer.[16] Immigrants from China typically had low ASMRs, but in Montreal, the cancer ASMR among women from China was comparable to that of Canadian-born women.[16]

Conclusion

The results of this study indicate an overall healthy immigrant effect that diminishes with years since immigration to Canada. Moreover, even after 20 or more years in the country, immigrants' ASMRs were generally lower than those of the Canadian-born population.

However, the analysis of ASMRs by birthplace, period of immigration

and area of residence in Canada reveals the heterogeneity between and within immigrant subgroups and highlights the importance of country-specific research at the CMA level.

As the percentage of the population made up of immigrants continues to grow, interest in their health status will increase. As a result, the need for in-depth analysis based on surveys with larger samples of immigrants and on linked data such as the Canadian census mortality follow-up study will also increase. ■

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